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Distribution range and ecological niche of *Primula marginata* Curtis (Primulaceae)

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Abstract: The distribution range of *Primula marginata* Curtis (Primulaceae) has never been fully characterized. In the present study authors did a revision of the distribution range using herbaria material, database records and *in situ* populations check-up. *P. marginata* was confirmed extending from Cottian to Maritime and Ligurian Alps, with few outlier occurrences in the northern Apennines. The localities previously reported from northern Piedmont (Val d'Ossola) were not confirmed. Maximum entropy model (Maxent) was used to simulate the potential distribution of *P. marginata* under current climate conditions. According to the distribution modelling performed, the species prefers rocky calcareous habitats mainly at high elevations, with abundant precipitation, but with low moisture retention at soil level and marked temperature range between winter and summer seasons. The potential distribution area drawn by Maxent seemed to describe *P. marginata* at its maximum extension and any future climate changes might cause limitations for the survival of the species.

Keywords*:* Distribution range, ecological niche, Western Alps, *Primula marginata*, distribution-modeling.

Introduction

Primula marginata Curtis is a chasmophyte very appreciated by horticulturists for its early pink-violet flowers and for its peculiar leaf colour and form. Its specific name is due to the conspicuous presence of a white calcareous secretion along the margins of the leaves, flower bracts, and sepals. In natural populations, the morphology of the plants may vary in colour, dimensions and shapes. However, the traits delimiting the taxon are always detectable and unambiguous.

P. marginata (2n = 62 and 126; syn. *P. crenata* Lam, *P. microcalyx* Lehm) belongs to *Primula* sect. *Auricula* Duby, as clearly demonstrated by recent molecular and taxonomical investigations (Conti *et al*. 2000; Zhang & Kadereit 2004, 2005; Mast *et al.* 2006); the species resulted closely related to *P. latifolia* Lapeyr. (2n = 64) and these two species were identified as the possibly earliest diverging lineage in subsect. *Euauricula* (Zhang & Kadereit 2004). All other species belonging to the same section are distinct from *P. marginata* for their not mealy leaves and for the length of glandular hairs (Richards 2003).

P. marginata geographic distribution range was never stated with high precision due to the frequent misidentification of the species in herbarium and literature records. In many herbaria, specimens belonging to *Primula hirsuta* All., *P. latifolia* Lapeyr., *P. cottia* Widmer, *P. villosa* Wulfen in Jacq., *P. pedemontana* Thomas ex Gaudin, *P. apennina* Widmer and *P. auricula* L. were often wrongly identified and labelled as *P. marginata*, resulting in an unclear circumscription of the species range, especially in the north. The distribution ranges of some of the above mentioned species overlap that of *P. marginata*. For instance, in the Maritime Alps, the co-occurrence of *P. marginata*, *P. latifolia*, *P. allionii* and *P. hirsuta* has been recording for many decades. In addition, at the extremes of its range, *P. marginata* is in contact with *P. cottia* (Val Pellice), *P. pedemontana* (Vallée du Queyras) and *P. apennina* (Northern Apennines).

Some karyological studies within *P. marginata* populations (Kress 1963, 1969) pointed out the

existence of two different cytotype groups (2n = 62 and 126 respectively), the former living in the north-western side, the latter in the eastern one (Zhang & Kadereit 2005). These different cytotypes do not correspond to different morphological, genetic, and ecological groups, as confirmed by a recent study (Casazza *et al*. 2012). The main aims of this paper were: a) to define the detailed circumscription of the distributional range of *P. marginata*, verifying the presence of disjoint occurrences in northern Piedmont (Val d'Ossola) and northern Apennines (Val Nure and Val Aveto); b) to define the ecological niche of *P. marginata*.

Materials and methods

Occurrence data

In order to cover all the assumed territory of the species all occurrence records of *P. marginata* were collected from:

- the database "SILENE" of the Conservatoire Botanique National Méditerranéen de Porquerolles (CBNMED) and "FLORE" of the Conservatoire Botanique National Alpin de Gap (CBNA) in France, both exported on November 2009 (http://flore.silene.eu);

- the database of the Istituto per le Piante da Legno e l'Ambiente (IPLA) in Turin (Piedmont - Italy), exported on December 2009;

- the database of the Repertorio Cartografico della Regione Liguria in Genoa (Liguria - Italy), exported on June 2010;

- the herbaria of Firenze (FI), Genova (GE), Torino (TO), Padova (PAD), Piacenza (PC), Portici (POR), Warsavia (WA) and the Museo Calderoni of Varallo Sesia in order to evaluate the original samples of Val d'Ossola;

- bibliographical records were taken in account and geo-referenced (Appendix I and II).;

- several field-trips to target areas of *P. marginata* were performed in 2008-2010 (Appendix III).

In order to eliminate a potential bias of occurrences indicated more times, the datasets were filtered so that there was only one record per 0.5 km^2 cell reported as centroid. These data were used in the successive analyses.

The number of occurrences per each administrative area (Liguria, Piedmont and Emilia Romagna in Italy; Provence-Alpes-Côte d'Azur in France), geographical subdivision of the Alps (Marazzi 2005), thermoclimatic belts according to the Worldwide Bioclimatic Classification System methods (Rivas-Martinez *et al.* 2004) and substrate type (calcareous vs. siliceous - Chantraine *et al.* 1996) were calculated by using DIVA-GIS version 7.1.2 (www.diva-gis.org).

Environmental variables

The 19 bioclimatic variables (Table 1) together with elevation data (Digital Elevation Model; DEM), at 30 arc-seconds (about 1 Km^2) of spatial resolution grid, were obtained from the WorldClim dataset (Hijmans *et al.* 2005; http://www.worldclim.org/bioclim.htm). These variables include the temperature and precipitation parameters that are biologically most meaningful to define the eco-physiological tolerances of a species (Graham & Hijmans 2006; Guisan *et al.* 2007a, b; Pearson *et al.* 2007; Kumar & Stohlgren 2009; Murienne *et al.* 2009).

All these grids were clipped to an area circumscribed between 42° 33' to 46° 51' N and 04° 02'. to 10° 43' E (geodesic system WGS84), which spanned portions of Italy, France and Switzerland and included the alpine sectors of the south and north-western Alps (Marazzi 2005) and the northern Apennines.

Modelling procedure

Maximum entropy modelling (Maxent) version 3.3.3a (Phillips *et al*. 2004, 2006; www. cs.princeton.edu/ ~schapire/maxent/) was used to estimate the potential ecological niche of *P. marginata*. The software is based on a machine learning response that is designed to make predictions from incomplete data. This approach estimates the most uniform distribution (maximum entropy) of sampling points compared to background locations given the environmental constraints derived from the data, (Phillips *et al.* 2006). Maxent has been shown to produce better results than other comparable methods such as BIOCLIM, DOMAIN or GARP in predicting the environmental requirements determining a species range (e.g. Elith *et al*. 2006; Wisz *et al*. 2008). The method requires only species presence data (not absence) and environmental variables (continuous or categorical) for the study area. It estimates the probability of species presence as a function of a set of environmental variables; the results may vary from 0.0 (lowest probability) to 1.0 (highest probability). Four probability classes were used according to Kumar & Stohlgren (2009): very low (< 0.1); low (0.1-0.4); medium (0.4-0.6); high (0.6-1). In this application, default parameters were used, except that a 25% random test percentage and 1000 maximum iterations were used.

Receiver Operating Character (ROC) curves were used by Maxent to evaluate model performance. The ROC curve is obtained by plotting sensitivity on the y axis and 1–specificity on the x axis for all possible thresholds; sensitivity and 1-specificity represent absence of omission error (true positive rate) and commission error (false positive rate), respectively. The area under the ROC function (AUC) is commonly used as a summary measure of diagnostic accuracy (DeLong *et al*. 1988). AUC can take values from 0.0 (no discrimination ability) to 1.0 (perfect discrimination). Jack-knife tests of variable importance were also performed to identify those bioclimatic variables with important individual effects (Pearson *et al*. 2007).

Results

Occurrence data

The locality data assembled from various sources amounted to a total of 2690 occurrences of *P. marginata*, including: 1973 occurrences from databases (576 from CBNA; 923 from CBNMED, 384 from IPLA; 90 from Regione Liguria); 709 occurrences from herbaria and literature (Appendix I); 28 occurrences from *in situ* investigations in those marginal locations of France and Italy where identification mistakes might be assumed according to the collector and period (until the XX century). Special effort was invested in verifying the locations reported in Val d'Ossola (northern Piedmont) and the northern Apennines by Pignatti (1982).

The total data set of 2690 occurrences was reduced to 1763 after filtering and recording only one record per 0.5 km^2 cell reported as centroid (Figure 1). The occurrences were subdivided by administrative areas according to the following manner: Italy 25.41% (Liguria 4.65%, Piedmont 20.36%, Emilia Romagna 0.40%); France 74.59% (Provence-Alpes-Côte d'Azur). According to the geographical subdivision of the Alps (Marazzi 2005), the occurrences belong to only four sections of the south-western Alps: Ligurian Alps 14.01%, Maritime Alps 46.51%, Cottian Alps 25.98%, Alps and pre-Alps of Provence 13.05%. The species was absent from the northern Piedmont (Val d'Ossola). Finally, 0.45% of the occurrences were found in the northern Apennines. According to the thermoclimatic belts (Rivas-Martinez *et al*. 2004) the occurrences belonged to 6 categories as follow: orotemperate = 48.72%; oro-submediterranean = 28.87%; supratemperate = 9.36%; mesomediterranean = 0.68%; meso-submediterranean = 1.25%; supra-submediterrenean = 11.12%. Finally, the occurrences were subdivided in 87.75% on calcareous vs. 12.25% on siliceous substrates.

The area of extent of *P. marginata* was estimated to include 13 370 km^2 for the Alpine zone, plus a single square kilometre for the occurrences in the Apennines. The area of occupancy was 9095 km^2 (calculated as the number of 1x1 Km cells where the species is present). *P. marginata* altitudinal range varied from 400 (Vallée de la Roya - France) to about 3000 m (Vallon de Taillante – Vallée

du Queyras - France).

Distribution-modeling

The Maxent model predicted the potential suitable ecological niche for *P. marginata* with high success rates (reg. training = 1.806) and scoring an AUC of 0.934 both for training and test data. The standard deviations of the test data was 0.003. Using four arbitrarily defined probability classes according to Kumar & Stohlgren (2009), the most suitable niche for *P. marginata* was predicted in the south-western Alps and pre-Alps of Provence (Figure 2), especially along the ridge of the Maritime Alps at the border between Italy and France. Note also that the Maxent model correctly predicted the existence of potential distribution areas (although with lower probability than in the south-western Alps) in the northern Apennines, where the species does occur. The model included 309 255 cells grid, of which 4.91% showed a low probability, 3.52% showed a medium probability and only 0.41% showed a high probability of suitable ecological niche (Table 2). Our modelling revealed that the majority of presence pixels within the study area were captured by Maxent in medium and high probability categories (89.34% of presence) while only the remaining 10.66% was in very low and low classes (Table 2).

Maxent selected three bioclimatic variables and elevation data from the WorldClim dataset as the four most important predictors of *P. marginata*'s potential distribution (Table 1): Elev - 'elevation' (33.2%), Bio04 - 'temperature seasonality (standard deviation)' (26.2%), Bio09 - 'mean temperature of driest quarter' (14.2%) and Bio18 - 'precipitation of warmest quarter' (14.2%)

The Maxent model's internal jack-knife test of variable importance (Figure 3) showed that 'temperature seasonality (standard deviation)' (Bio4) was the environmental variable with highest gain when used in isolation. 'Elevation' (Elev) is the environmental variable more decreasing the gain when omitted , and therefore it appeared to have the most information not present in the other variables.

The optimum values of the selected variables were as follow (Figure 4): elevation between 1000 to 2500 m a.s.l. (Figure 4A); temperature seasonality (variation among monthly mean values) ranging

from 5.5 to 6.0 °C (Figure 4B); mean temperature of the driest quarter between 5 to 15 °C (Figure 4C); precipitation of the warmest quarter varying from 200 to 350 mm (Figure 4D).

Discussion

The species' distribution range

Issued floras (Tutin *et al*. 1972; Pignatti 1982; Aeschimann *et al.* 2004) and scientific papers (Smith *et al*. 1984; Richards 2003; Zhang & Kadereit 2004) show different descriptions of *P. marginata*'s distributional range. In the present study all known occurrence records of *P. marginata* gathered from literature, herbaria and data bases were assembled and more than fifty of them were verified in the field. The present distributional range is defined as follow: the northern limit runs south of Val Susa in the Cottian Alps (two occurrences recently recorded in Val Thuras at 44°53'37" N), from which the eastern limit follows the base of Piedmont's mountains down to the Ligurian Alps at their eastern extreme (M. Carmo di Loano - 08°11'18" E); the southern limit includes most of the foothills region south of the main chain (above Menton), down to the Cime du Cheiron and the Vallée de l'Artuby (M. Broves upon La Martre at 43°44'44" N) in the Alpes de Provence; the western limit includes the peaks east and north of Digne, then turns to follow the eastern flank of the Vallée de la Durance (La Motte du Caire at 06°01'21" E), then up to the Guil torrent and to the northern Queyras. The disjoint occurrences in the Apennines should be added to this main distributional range, thus extending the easternmost border to the Aveto Valley in the northern Apennines (Passo della Roncalla at 09°29'01" E).

Authors visited the localities of Passo del Turlo – M. Rosa (upper Val Sesia) and two localities just below Macugnaga (Val Pizza and Valle Anzasca) according to the information reported in literature concerning the northern Piedmont (Biroli 1808; Colla 1835; Bertolani Marchetti 1954; Fenaroli 1998) and the localities reported on herbarium specimens collected by Carestia [FI, GE, PAD, PC, POR, TO, WA and Museo Calderoni at Varallo Sesia] and Balbis (TO-HP),. During those field

trips only large populations of *P. hirsuta* (kept in GE) were detected.

The distribution map of the localities assembled in our database (Figure 1) provides a global view of the extent of the species over four sections of the south-western Alps (Ligurian, Maritime, Cottian and Provencal Alps) and identifies areas where occurrence density is particularly high. They are located in Val Gesso, Val Vermenagna, upper Vallée du Vésubie, Vallée de l'Ubaye and Vallée du Guil (Queyras). However, the preponderance of records from the aforementioned areas might simply reflect a collecting bias, because they are all areas easy to reach. Considering the occurrences recently indicated in the northern Apennines, *P. marginata* is not restricted to the south-western Alps as implied by most authors (Tutin *et al.* 1972; Pignatti 1982; Smith *et al*. 1984; Richards 2003); for this reason the species can not be considered endemic to SW Alps. Furthermore, the species is not included in any IUCN category because it is locally abundant and, at present, it does not show any signs of decrease in any part of its distributional range.

Ecological preferences and distribution-modeling

Niche modeling investigation has been recently used to predict current species distributions as input for conservation planning and to understand environmental correlates of species occurrences (Elith *et al.* 2011; Tsiftsis *et al.* 2012; Van Gils *et al.* 2012). In our study, maxent model predicted a potential distribution for *P. marginata* mainly based on few variables (Table 1). The low variation among monthly mean temperature values (Figure 4B) is generally typical of the temperate climate present in the Alps (Rivas-Martinez *et al*. 2004), where the difference in temperatures among seasons is quite minimal. The optimal elevations for *P. marginata* (Figure 4A) were inferred from subalpine and alpine altitudinal belts (Aeschimann *et al*. 2004). Furthermore, the mean temperature of the driest quarter (Figure 4C), is typical of -high elevations during the summer period. Finally, mean precipitations in the warmest quarter can be referred to upper altitudinal belts during summer (Figure 4D), when orographic clouds and diurnal storms are frequent. In conclusion, all bioclimatic conditions explaining the predicted potential suitable niche for *P. marginata* completely fit the subalpine and alpine belts in the south-western Alps.

Only a few populations were reported from low altitudes (near Menton and Ventimiglia) and included only a few individuals each. Such groups of plants occur on north-facing rocks seldom exposed to sunlight or in woody places with higher air humidity. The eight occurrences in the northern Apennines, including a larger number of individuals, were located at altitudes above 1500 m and northward exposed, where snow cover remains at least for five months a year. Indeed, plants of *P. marginata* from the northern Apennines that were cultivated *ex situ* for three years at the Genova Botanic Garden never flowered, possibly underscoring the need of cold winter temperatures to trigger flowering in individuals from these localities (personal data).

Maxent model predicted a potential distribution of *P. marginata* mainly located (87.59%) into the oro-submediterranean and orotemperate thermoclimatic belts (Rivas-Martínez *et al*. 2004), with quite low temperatures year-round (comparable with Bio04 of WorldClimat). The variation of neighbouring thermoclimatic conditions seems to limit plant distribution: the eastern border with the presence of the supratemperate conditions (with hot summer); the southern border with the dominance of mesomediterranean bioclimate (mild winter and summer); the western border with meso-submediterranean and supra-submediterranean conditions that are only partially (12.37%) tolerated by *P. marginata*. Also at the northern border of *P. marginata*'s distribution, the alpine bioclimatic conditions seem to limit its occurrence, owing to increasing annual precipitations (Bio18 > 400 mm) recorded in the central and northern sectors of the Alps, from Val Susa eastbound (Frei & Schär 1998; Auer *et al*. 2001). According to our niche modelling analyses results, the mentioned climatological features appear to minimize the expansion capability of the species.

Even if most of occurrences were detected on calcareous substrates, a low percentage (12.25%) of its distribution range was characterized by siliceous rocks (Chantraine *et al*. 1996); for this reason, substrate may not represent a crucial factor in limiting the range of *P. marginata*. The potential distribution area drawn by Maxent (high and medium probability classes of suitable ecological niche in Figure 2 and Table 2) seemed to describe *P. marginata* at its maximum extension. This observation fits the speciation model proposed by Zhang & Kadereit (2004), according to which in

Primula sect. *Auricula* the opportunity for speciation decreased as ecological or geographical space became filled by newly formed taxa.

The biogeographic interpretation of the disjoint occurrences in the northern Apennines is quite problematic: they might either represent a residue of the ancient extent of *P. marginata* during the Last Glacial Maximum, or they might represent the results of long distance stochastic events reaching a small suitable area.

Any future climate changes might cause limitations for the survival of the species in the present distribution area. A warming climate would probably force the plants to migrate either at higher altitudes or to the north along the Alpine chain. In this scenario, the competition with other co-generic taxa (i.e. *P. hirsuta* and *P. pedemontana*) might limit a potential species range expansion to the north. Further ecological niche modeling studies, involving all co-generic taxa and based on future climatic scenarios, are necessary. Populations growing at the southernmost distributional limit of the species and at lower altitudes might contract, causing a variation of the species' area of occupancy according to IUCN. Anyway, the species can not be considered on threat due to its so large area of extent, area of occupancy and the large number of occurrences recorded since last centuries. Nevertheless, future studies on reproductive biology and population genetic of *P. marginata* are necessary in order to forecast any possible effect of climate change, as already performed on other species of the same genus (Fisogni *et al.* 2011) or belonging to the same geographical area (Minuto *et al*. 2004, 2005; Caporali *et al*. 2006; Minuto *et al*. 2006).

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Table 1. – Selected bioclimatic variables and elevation data from the WorldClim dataset and their percent contribution in Maxent model for *P. marginata* in its distribution range.

Environmental variable	**Percent contribution**	**Permutation importance**
Elevation (m)	33.2	74.0
Temperature seasonality (sd*100 - Bio4)	26.2	0.1
Mean temperature of driest quarter (°C - Bio9)	14.2	0.1
Precipitation of warmest quarter (mm - Bio18)	14.2	5.8
Temperature annual range (°C – Bio07)	4.2	0.0
Mean temperature of wettest quarter (°C - Bio8)	1.2	0.7
Isothermality (*100 – Bio03)	1.2	0.1
Max temperature of warmest month (°C - Bio5)	1.1	6.8
Annual mean temperature (°C – Bio1)	1.0	1.2
Precipitation of coldest quarter (mm - Bio19)	0.7	2.6
Mean diurnal range (mean of monthly - °C – Bio2)	0.7	0.2
Precipitation seasonality (coefficient of variation, Bio15)	0.6	2.0
Mean temperature of coldest quarter (°C – Bio11)	0.5	5.5
Precipitation of wettest quarter (mm - Bio16)	0.5	0.0
Annual precitipation (mm - Bio12)	0.3	0.4
Precipitation of wettest month (mm - Bio13)	0.1	0.0
Precipitation of driest month (mm - Bio14)	0.0	0.3
Mean temperature of coldest quarter (°C – Bio10)	0.0	0.0
Max temperature of coldest month (°C – Bio6)	0.0	0.0
Precipitation of driest quarter (mm - Bio17)	0.0	0.0

Table 2 – Repartition of grid cells and observed points on the base of the potential distribution area performed by Maxent for *P. marginata*. Four probability classes were used: very low (< 0.1); low (0.1-0.4); medium (0.4-0.6); high (0.6-1)

	model grid cells %	model points %
very low	91.16	1.08
low	4.91	9.59
medium	3.52	73.06
high	0.41	16.28

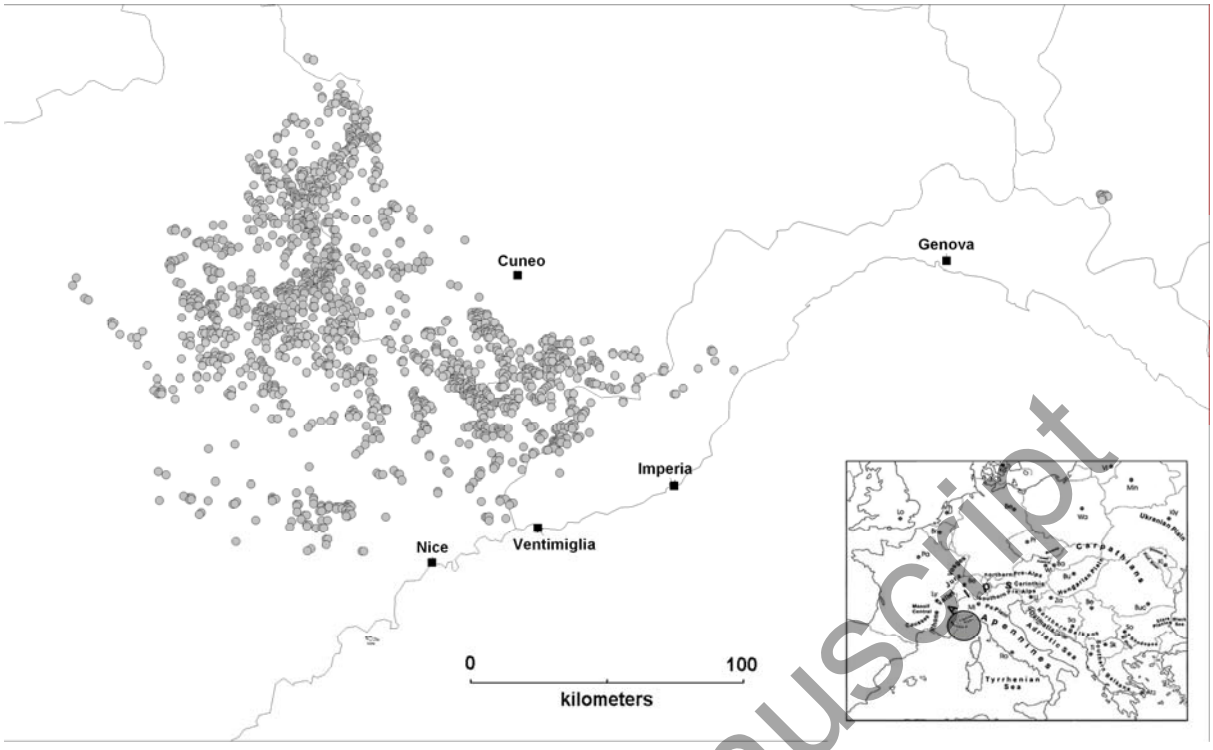

Figure 1. – Distribution range of *P. marginata*'s populations. The original 2690 occurrences were reduced to 1763 centroids of a 500x500 m grid and here represented.

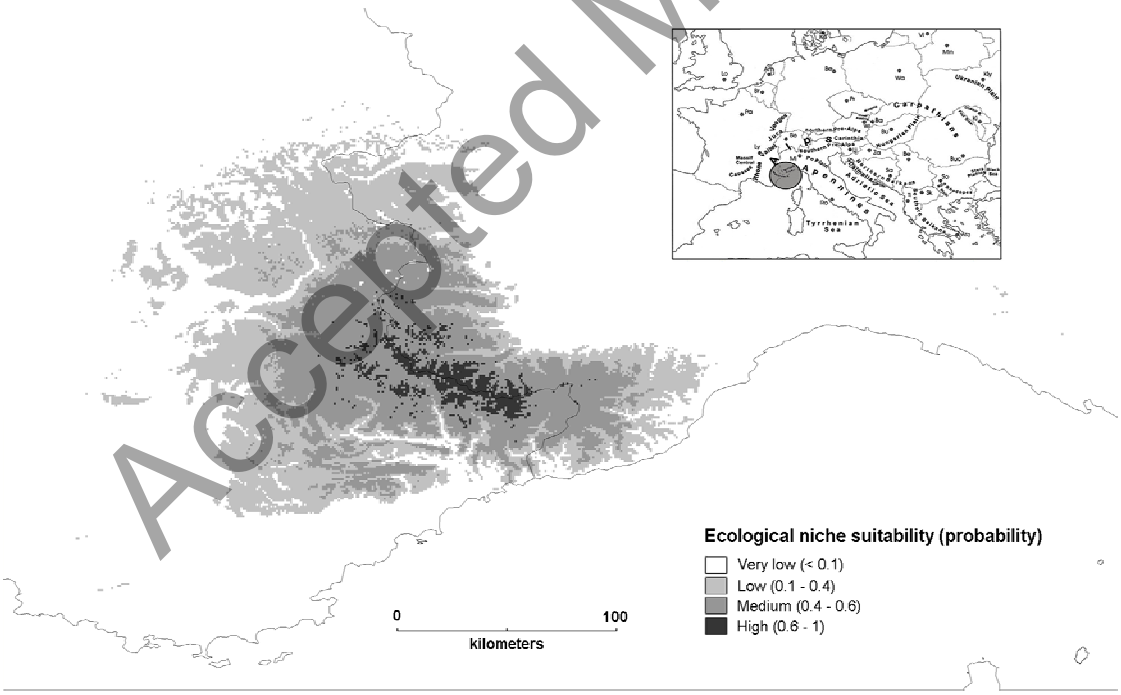

Figure 2. – Predicted potential distribution for *P. marginata* in NW Italy and SE France. Probability classes of ecological niche suitability as in Table 2: very low (white); low (light grey); medium (grey); high (dark grey).

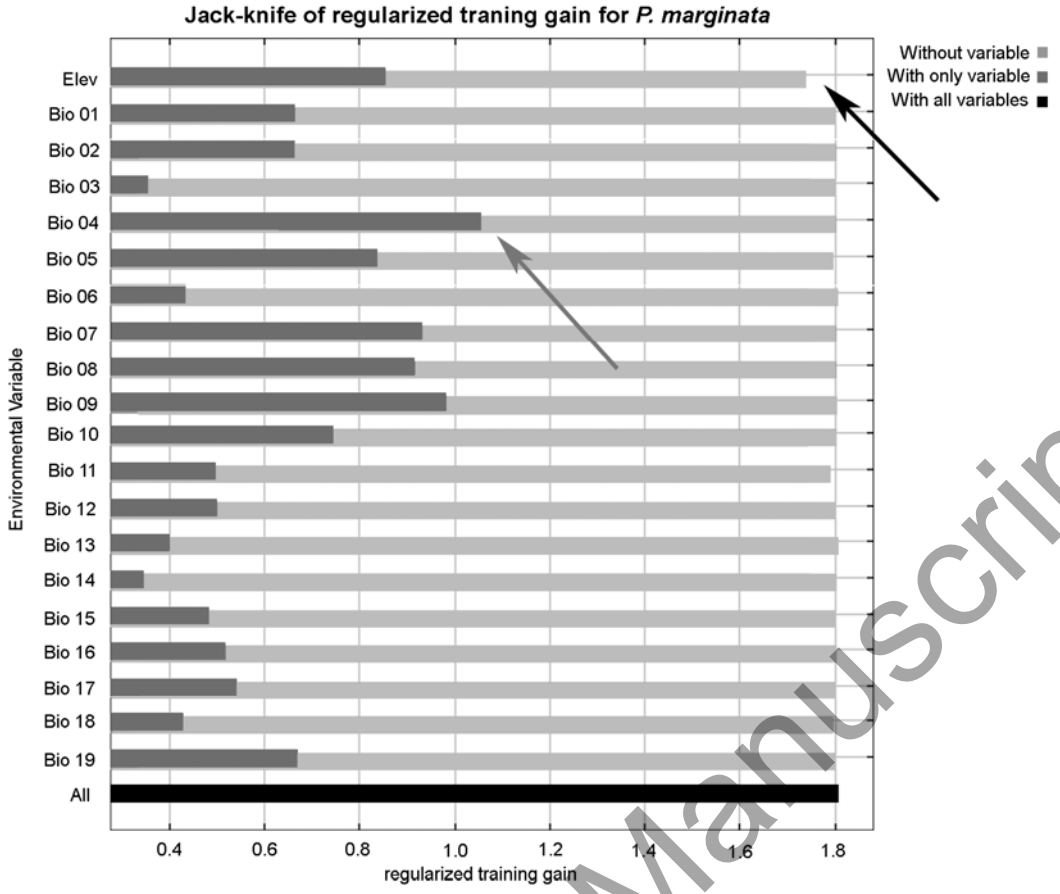

Figure 3. – Results of jack-knife evaluations of relative importance of predictor variables for *P. marginata* Maxent model. In the histogram dark grey bars indicate the regularized training gain for each variable when used in isolation; light grey bars show same value when the variable is omitted. The variable with highest gain when used in isolation is Bio4 (grey arrow), while the variable that decreases the gain the most when it is omitted is Elev (black arrow). For WorldClim variables, see Table 1.

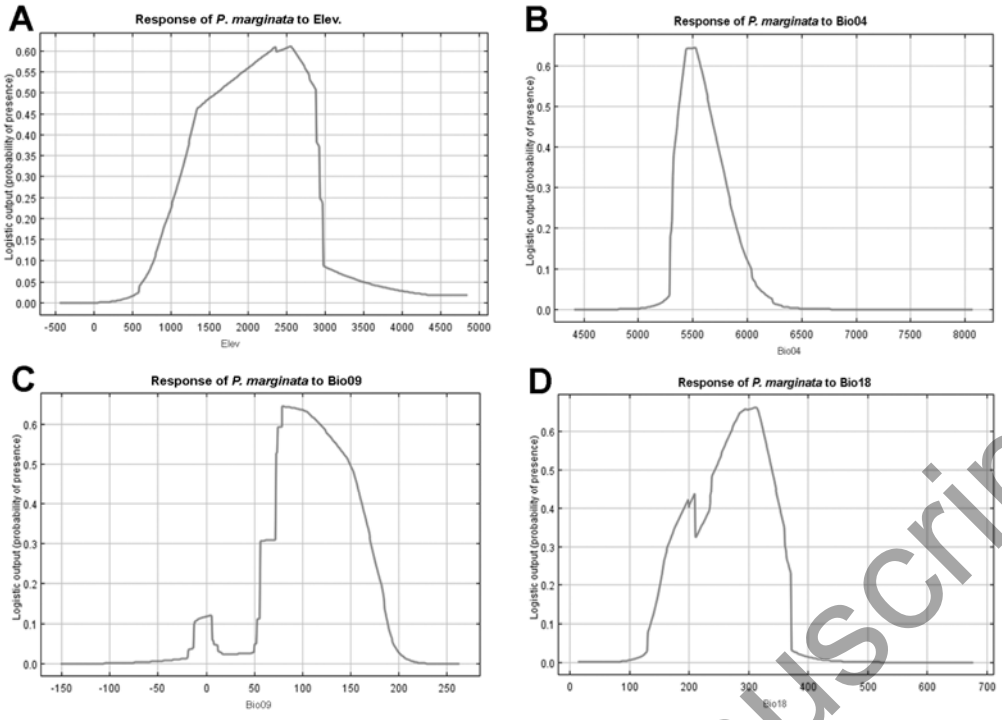

Figure 4. – The response curves of environmental variables (elevation and WorldClim variables 04, 09 and 018) affecting the Maxent prediction for *P marginata*.

Appendix I – *P. marginata* herbaria and literature investigation results. The references are reported in the text or in Appendix II.

SPECIMINA VISA – **Francia** – Nizza: nelle Alpi Marittime sopra Nizza, giugno 1864, *Barla* (FI). Val Bevera: Alpes Maritimes, Mont Aution, 27/05/1886, *Revercheron* (FI). Val Blanche: Seyne à Dormilhouse, 25/06/1900, *Bessand* (FI). Val Queyras: rochers au dessus de l'Echalp (H.tes Alpes), 2300 m, estate 1905, *Albert* (FI); ibidem, 2000 m, 27/06/1905, *Albert* (FI); ibidem, estate 1906, *Albert* (FI); Abriès en Queyras (H.tes- Alpes): rochers moussus dans les bois de mèlèzes, 1500, 08/08/1883, *Arvet-T.* (FI); Guillestre à Gévaudan, mai 1854, *Huguenin* (FI); ibidem, 25/01/1905, *Huguenin* (FI); ibidem, 1852, *Huguenin* (FI); ibidem, ?, *Huguenin* (TO); Rocher schisteux à l'Echalp, 2000 m, 24/06/1905, *Petitmengin* (FI). Val Roya: regni alpini montagne de Cairos, 11/05/1880, *Barla* (FI); rochers au Col de Tende, 28/06/1862, *Bourgeau* (FI); Alpi Marittime a Valmasca, 23/07/1908, *Corradi* (FI); Colle di Tenda sulle roccie (Alpi Marittime), 16/06/1891, *Ferrari* (FI); rupi tra il Colle dei Signori e il Colle di Malabera, 30/06/1909, *Ferrari, Gola* (TO); montagne de Tende, ?, *Perez* (TO); alpes de Tende, Juli 1843, *Reuter* (FI); Val de Cairos Alpes Maritimes, 1826, *Reuter* (FI); Tenda Alma Croesa, 25/04/1873, *Sternberg* (FI e due a TO); Alp. Marit. Tenda: Ciapea, 22/04/1873, *Sternberg* (TO); Alp. Mar.: M. Orno, 02/10/1872, *Sternberg* (TO); Tenda: Croesa (Nebenthal des Refrej), 29/08/1872, *Sternberg* (TO); Alpi Maritt: Castrignì e Fontanalba, 11/08/1872, *Sternberg* (TO); salita a Casterino (Alpi Marittime), 20/07/1908, *Vaccari* (FI); Casterino (Alpi Marittime) sule rupi calcaree a sinistra del torrente, 1600-1800, 20/07/1908, *Vaccari* (FI); rupi calcaree intorno a Tenda Val Roya, 05/05/1897, *Vallino* (TO). Val Tinée: rochers du Mont Monnier en suivant le chemin du Lac Lignes (de Hayet), 05/08/1855, *Chabert* (FI); Alpi Marittime. Monti presso Auron: Las Donnas - 2400 m, agosto 1970, *Pichi Sermolli* (GE). Val Ubaye: Barcelonnette (Basses Alpes), juin 1864, *Burlet* (FI); ibidem, juillet 1893, *Derbes* (FI); ibidem, mai 1848, *Huguenin* (FI); Basses-Alpes, Barcelonnette, sur les rochers dan les eboulis, 10/06/1897, *Marty* (FI); Basses-Alpes: Larche, au Nord du col, rochers, 2200 m, 10/08/1933,

Milliat (FI); Larche au Vallon de Courrouit, 29/06/1896, *Vidal* (FI). Val Verdon: La Condamine (Basse Alpes), 14/04/1884, *Orval* (FI). Val Vésubie: in rupibus montis "Balma de la Frema" prope "S. Martin Vésubie" [Colmiane Valdeblore] - solo calcareo, 2240 m, giugno 1895, *Vidal* (GE); Alpi Marittime: St. Martin Vésubie, Passo del Ladro, 25/07/1910, *Pampanini* (FI); Utelle a Manorcina [?], 26/5/1889, *Vidal* (FI). **Italia** - Magliolo: Liguria Occid. Loano M. Carmo, 1300 m, suolo calcareo, 07/06/1925, *Bolzon* (FI). Val Aveto: M. Groppo Rosso, 1580 m, 25/08/1992, *Martini* e *Bernardello* (FI). Val Corsaglia: Bussea: rupi del Mondolé, 11/06/1897, *Ferrari* (TO); M. Mondolé, alla vetta tra le rupi, 11/06/1897, *Ferrari* (FI); in cacumina nord colle di Mondovì in Sbris [?], 01/08/1866, *Romano* (TO); Mondovì: Mongioje, 08/03/1905, *Santi* (TO); rupi del Mondolé (Alpi Marittime), 11/06/1897, *Valbusa* (TO). Val Gesso: Borgo S. Dalmazzo, rupi del M. Sabench, 06/06/1929, *Fontana*, *Mussa* (TO); ad rupes secus viam Valderii, ? (sub *P. santii*) (TO); in pascuis Valderii prope il piano Vallone Vallace [?] ad Sanca, 1844, ? (TO); Valdieri Vallone Sarca, ?, *Boggiani* (FI); rupi calcaree di Cima Saben e Pissousa sopra Valdieri in Val Gesso, 1600-1800 m, 07/07/1962, *Bono* (FI); rupi calcaree presso Valdieri (Val Gesso - AM), 1150 m, 07/07/1961, *Bono* (FI); rocce calcaree tra Andonno e Valdieri, 750 m, 29/07/1961, *Bono* (FI); in pascuis prope Thermas Valderii, 17/07/1844, ? (TO); ad rupes in alpe Valderia a Stella, agosto 1826, *Bertero* (TO); Valdieri pareti E di Testa del Claus, Can. Cessole, 2700-2900 m, 05/08/1902, *Boggiani* (FI); rocce calcaree sulla Cima dell'Arp presso Valdieri, 1750 m, 13/07/1962, *Bono* (FI); ad rupes di Entraque, agosto 1826, *Bertero* (TO); ibidem, 30/12/1904, *Dessus* (TO); Entraque: rupi dietro la Chiesa, 10/08/1924, *Fontana* (TO); Piemonte, Trinità di Entracque rocce umide e ombrose sul Torrente Bousset poco a valle del Suffiet, 1140 m, 29/07/2006, *Selvi* (FI); Entraque, giugno 1931, Boggiani (FI); rupi alpine del Monte Bissa [Rocca Abisso], 10/08/1869, *Parlatore* (FI); Entraque: Argentera, giugno 1899, *Santi* (TO); S. Anna di Valdieri, Vallone della Meris, 08/07/1906, *Ferrari*, *Vallino*, *Gola* (TO). Val Grana: Castelmagno roccie sulla grotta di Pattarona, 09/08/1909, *Zola* (sub *P. santii*) (FI). Val Grande: Vernante: Vallone di Pallanfré sopra il Gias Colombo (Alpi Marittime), 26/07/1892, *Belli* e *Ferrari* (TO); Alpi Marittime. Cresta rocciosa sopra il Gias Colombo. Vallone

Pallanfré di Vernate, Luglio 1892, *Vallino* (TO). Val Maira: Sulle rupi elevate nella Valle Macra, agosto 1844, ? (TO); ad rupes in Valle Macra ubique, 02/08/1845, ? (TO); in valle Macra, 1847, *Huguenin* (TO); Rupi della valle Macra e Varaita, 1880, *Rostan* (FI); Valle Maira, luglio 1889, luglio 1910 - luglio 1908, *Ussolo, Santi* (TO); Val Maira - A Chiappera su un masso presso l'abitato, 07/07/1995, *Abbà* (TO); Alma Vallone Albaretto verso il Rio Interselle, 01/07/1910, *Ferrari, Gola* (TO); Valle Macra - Chiappera, sulle rocce oltre le cascate di Stroppia, 1650 m, 05/06/1977, *Forneris* (TO); Valle Macra - Chiappera, nelle fessure delle rocce salendo oltre il Col Maurin, 2700 m, 12/08/1977, *Forneris* (TO); Acceglio: rupi sotto il Colle Maurin, 2550 m, 28/07/1910, *Gola, Santi* (TO); Fenestra Machego Maurin, n°2731, *Perez* (TO); ibidem, ?, *Perez* (TO); Acceglio: Vallonetto di Fissera de Maurin al Collet del Vallon de Fissera nelle rupi, 2800 m, 29/07/1910, *Ferrari, Gola, Santi* (TO); Sorgenti del Maira. Valle Macra, rupi nei boschi di *Pinus uncinata*, 1580 m, 15/08/1968, *Montacchini, Bono, Ariello* (TO); Comba Emanuel (Vallone di Prarione - Val Macra - Alpi Cozie), 11/08/1897, *Valbusa* (TO); Val Maira - Vallone Marmora, 2100 m, 21/06/1968, *Rasetti* (FI); ciglio del Vallone di Elva, 1400 m, 09/06/1965, *Salotti* (TO); S. Damiano Macra: rupi a destra della Macra, 22/06/1911, *Ferrari, Gola* (sub *P. santii*) (TO); Dronero (Val Macra) conglomerati sulla riva destra della Maira, 04/05/1915, *Ferrari, Gola* (sub *P. santii*) (TO); Dronero (Cuneo) sulle rupi di conglomerati sulla destra della Macra, 1902-1914, *Ferrari, Vallino, Santi, Gola, Mussa, Noelli, Raineri* (sub *P. santii*) (TO); Dronero rupi a monte della Macra, 23/06/1907, *Ferrari, Vallino* (sub *P. santii*) (TO); ibidem, 1889/1908/1910, *Ferrari, Gola, Santi* (TO); ididem, 1902-1921, *Vallas, Tesser, Gola, Santi, Mussa* (sub *P. santii*) (TO); ibidem, giugno 1907, *Vallino* (TO); ad rupes Dronero et prossimum in Valle Macra usque ad supremas collas (sub *P. santii*) (TO). Val Nervia: in rupibus prope M. Tenarda supra Pigna Liguria, 1400 m, 10/04/1899, *Bicknell* (FI); Rio Incisa sotto M. Toraggio, 22/04/1895, *Bicknell* (FI); Liguria Occid. Provincia di San Remo Monte Marta sopra Pigna, giugno 1847, *Panizzi* (FI). Val Neva: roccie al passo delle Cavanche su Erli- Nasino, alta Valle Neva, 1898, *Vallino* (TO). Val Nure: alta Val Nure, vers. N delle Groppe di Selva, comune di Ferriere (PC). c/o "La Grotta" (P.so Crociglia e P.so Roncalla),

1500-1600 m, 03/06/1991, *Bonafede* (FI). Val Pellice: misit vivam Cl. D E Rostan S. Germano di Pignerolo, 1891, *Levier* (FI); fessure delle roccie nel Colle della Croce presso Viso, 1855, *Rostan* (FI); fessure delle rupi nel Colle della Croce Val Pellice, giugno 1880, *Rostan* (FI); Colle della Croce presso Viso, 28/01/1905, *Rostan* (FI); San Germano di Pignerolo Massif Vivane, 1891, *Rostan* (FI). Val Pennavaire: rupi del Monte Galé (Galero), 1700 m, giugno 1891, *Fiori* (FI). Val Pesio: Valpesio, 1000 m, 21/04/1947, *Berenti* (FI); Pesio, agosto 1826, *Bertero* (TO); sui rupi nel V. Marguareis di Pesio Alp. Mar. Piemonte, 25/06/1890, *Bicknell* (GE); Val Cravina V. Pesio, 29/06/1888, *Bicknell* (GE); Certosa di Pesio sulle rupi Rocce Bruseis, 17/08/1916, *Ferrari, Santi, Mussa* (TO); Certosa di Pesio: rupi tra il Gias dell'Urtica e il Colle di Malabora, 20/07/1901, *Ferrari, Vallino* (TO); Val Pesio Roccie Bruseis, 18/05/1946, *Piovano* (TO); sopra Certosa di Pesio, 14/06/1931, *Santi* (TO).Val Roaschia: Val de Roaschia dans la Vallée du Gesso de Valdiera (Alpes Maritimes du Piemont meridional): rochers, 760 m, 28/04/1885, *Burnat* (FI); Val Roaschia, 1800 m, 16/06/1968, *Rasetti* (FI). Val Stura: Valle Stura di Demonte. Presso la Galleria delle Barricate, 1400 m, 26/06/1993, *Abbà* (TO); Val Stura Vallone Neraissa, 1200 m, 14/08/1963, *Bono* (FI); Vinadio nelle roccie salendo lo Schiattare [Ischiator] (Alpi Marittime), 30/07/1889, *Ferrari* (2 a FI e TO); Terme di Vinadio: nelle roccie salendo lo Schiattore (Alpi Marittime), 30/08/1889, *Ferrari* (TO); Pietraporzio: Vallone di Ponte Bernardo rupi di Stan, 22/07/1895, *Ferrari* (TO); fessure delle roccie fra le Pianche e le Terme di Vinadio e salendo lo Schiattore, 27/07/1889, *Ferrari* (TO); Alpi Cozie -Valle Stura, Rittane sopra la borgata Gorré presso il Colle della Gorgia, pendio roccioso, silice, 1580 m, 09/04/2001, *Pascale* (TO); Vallone Ferriere, rupi presso il colle del Colombard (Val Stura - Alpi Marittime), 10/08/1897, *Valbusa* (TO); rupi nel Vallone di S. Anna di Vinadio, 16/07/1895, *Valbusa* (TO). Val Tanaro: Mongioje rupi presso il Bochin d'Aseo, 18/06/1894, *Ferrari* (TO); Val Tanaro: Monte Antorotto Alpi Marittime, 2100 m, luglio 1891, *Fiori* (FI); Nava ad rupes, 01/08/1866, *Romano* (TO); Ormea ad rupes alpinas di Pietragrossa, 02/08/1869, *Romano* (TO); Alpi Maritt.: M. Sciaccaré, 27/07/1872, *Sternberg* (TO); Gola della Ciusetta nel Vallone di Carnino, 21/07/1896, *Valbusa* (TO). Val Varaita: sulle rupi nei luoghi

elevati delle alpi della Valle di Varaita, 1845, ? (TO); Col di Vallante Monte Viso ex regione alpina Alpium Cottiarum, 27/07/1860, *Ball* (FI); Mont Viso, 1876, *Jordan* (FI); Vallone delle Forciolline. Rupi lungo il sentiero, luglio 1887, *Vallino* (TO); Alta Valle Varaita di Bellino, località detta Le Barricate, 22/08/1907, *Zola* (FI); Alta Valle Varaita n° 3564, agosto 1902, *Zola* (FI). Val Vermenagna: comunissima sulle rupi tra le alpi di Limone ed Ormea, luglio 1844, ? (TO); ad rupes a Tenda ad Vinadium, lugli/agosto 1843, ? (TO); in alpibus di Tenda, 20/05/1856, *Ardoino* (TO); Limone: Colle di Tenda, 21/06/1893, *Belli* e *Ferrari* (TO); sulle rocce del Colle di Tenda, 1900 m, 11/09/1892, *Biondi* (FI); Tenda: rupi sotto il Castello della Maima (Alpi Marittime), 06/05/1897, *Ferrari* (TO); rupi del Colle di Tenda, 16/06/1891, *Ferrari* (TO); Alpi di Tenda, *Levier* (FI); rupi del Colle di Tenda presso il Forte, 14/09/1892, *Martelli* (FI); rupi del Col di Tenda per andare a Limonetto a 1900 m in regione alpina, 09/08/1869, *Parlatore* (FI); Limone Piemonte: tra Maire del Cros (m 1400) e M. Crest (m 1700), 20/07/1949, *Pichi Sermolli* e *Contardo* (FI); Limone a Tenda, giugno 1893, *Santi* (TO); Col di Tenda a levante del passo, 07/08/1872, *Sternberg* (FI); Col di Tenda , 07/08/1872, *Sternberg* (TO); Castello di Merima - Tenda. Rupi e boscaglie, 1100-1400 m, 06/05/1897, Valbusa (FI); Tenda sotto il Castello di Maima, 06/05/1897, *Valbusa* (TO); Boscaglie sotto il castello di Maima (Tenda - Alpi Marittime), 06/05/1897, *Valbusa* (TO); roccie a NO di Tenda presso il Castello di Maima, 1897, *Vallino* (TO); Località sconosciute: ?, A Schleicher, 1823, *Balbis* (TO); ?, Alpi …… *Biroli* (TO); ?, *Biroli* (TO); ?, Alpe Vuperai (?), 15 luglio 1867, *Ricca* (FI); ?, Alpi Maritt.: Mappa, 15/07/1872, *Sternberg* (TO); 1880, ? (TO).

EX LITERATURA – **France** – Menton: M. Mulacé - M. Aguglia (Bicknell, 1885); Menton; Bois du M. d'Or près Lucéram (Riocreux), 21/04/1864; M. Férion, env. de Nice, rochers calc., 1400 m, 11/06/1903; M. Aiguille, 07/04/1877, leg. *Barbey*, (Charpin & Salanon 1985). Val Artuby: Mont Broves – La Martre (Rouy 1908); La Martre rochers a l'Ouest de la Montagne de Brouis, leg. *Albert* (Albert & Jahandiez 1908); La Martre M. Brouis, leg. *Albert* (Roux 1881). Val Bevera: M. Grammondo; M. Authion (Bicknell 1885); La Martre a W de M. Brouis (Albert & Jahandiez 1908);

M. Brouis (Thompson 1914); Altopiano Authion a N del P. del Turini (Kress 1969). Val Blanch: Saint-Pons (Seyne) (Rouy 1908). Val Bleone: Prads, bord de la Bleone (Roux 1881). Val Esteron: rocher de la Clue de Saint Auban (Albert & Jahandiez 1908); Cheiron (montagne del) (Kress 1969); vis-à-vis Le Mas (St. Auban), 30/05/1875; St. Auban, 1876, leg. *Raubert*; Clue de St. Auban, rochers calc., 1000-1100 m, 28/051903; M. Cheiron, 05/1885, leg. *Rastoin Brémond*; env. de St. Auban, débouché N de la cluse de Gaves, rochers calc., 650 m, 28/06/1909; signal d'Harpille entre le Mas et St. Auban, rochers calc., 1500-1680 m, 26/06/1909; fissures des rochers du M. Cheiron au Pic de Jérusalem, 30/05/1896; Cheiron (La Boumace), commune de Sigale, 12/05/1869, leg. *Consolat*; Montagne du Cheiron entre Coursegoules et Vegay, Col de Vegay, 15/06/1863 (Charpin & Salanon 1985); Greolieres / presso Cipieres (Zhang & Kadereit 2004). Val Gordolasque: Vallon de l'Autier pareti lungo il sentiero, 1934 m; Lac de l'Autier, 2282 m; Vallon Cabret lato E del fiume, 2119 m; Cascades sentiero del Rifugio Nizza, 1927; Mur des italiens pareti sul lato NE, 2012 m (Arroyo Gutiérrez 2005). Val Marveilles: Tête de Basto, 2700; Chaminieyes en esposition NE, 2700; Cime du Capelet, 2500; Cime du Grand Capelet, 2800; Rupicoles du Mont Bego, 2100 (Barbero & Bono 1967); Fontanalba Lac Mouton, 2187; Lac de Merveilles, 2353 m; Lac du Bast e Lac Noir, 2378 m; Vallon de la Miniere, (Arroyo Gutiérrez 2005). Val Queyras: Col de l'Izoard; Vallon de la Taillante (Grenier & Godron 1850); Chateu Queyras fiume Guil, 1350 m; La Chalp - St. Véran; strada per Vars a 5 km da Guillestre (Kress 1969). Val Roya: presso Tenda, 800 m (Kress 1969); tra Vievole e Col di Tenda, 1000 m; Arma-creuza Tende, 850 m; Vallée du Riofreddo, 800 m; Rocher a l'E de Tende, 750 m; Col de Tende prés du tunnel, 1300 m (Rioux & Quezel 1949); M. Beoulet prés du Col de Brouis, 1490 m, 20/06/1903; M. Ventabren prés Breil, rochers calc., 1500 m, 26/06/1904; rochers au Col de Tende, 28/06/1861, leg. *Bourgeau*; Col de Tende, 1857, leg. *Thomas*; Punta Peirafica, parete N, silice, 2500 m, 23/07/1909; partie inf. du Sialetta qui se jette dans le Riofreddo de Tende, 11/09/1892, leg. *Bastreri*; Val Merima, vallée latérale au Val Cairos, 13/04/1876; Val Riofreddo près Tende, env. du pigeonnier; régione alpine mont. de Cairos, 11/05/1880, leg. *Barla* (Charpin & Salanon 1985); rochers du Cairon tra Vieve e il

tunnel di Tenda; Valle de la Pia - Riofreddo tra le Grange de la Varne e C. de Velegue; rochers de Servia c/o Bergue sup. (Zappa 1990); Monesi verso il Col di Tenda a sud del Rifugio Morgantini a N di Castel Frippi, 2200 m (Zhang & Kadereit 2004). Val Tinée: M. Mounier prairies; Col de Vens prairies, 2700 m; Vallée de Rabuon M. Pelego, 1700 m (H. Cousturier); Massif du Mounier, Peira Blanca, rochers du versant N, calc., 2100 m, 22/07/1913; rochers près Margheria di Rora, Val Longon près St. Sauveur, 03/07/1875; sommet du Col del Ferro entre les vallées de Tinée et Stura, 02/08/1883; Col de Pouriac, versant de Salza Morena, 02/08/1877; M. Mounier rochers de l'arete, calc., 2700-2800 m, 17/07/1902; bloc isolé au S du M. Mounier, calc., 2250 m, 11/07/1904, leg. *Saint Yves*; massif du Mounier, Cime de Sadours, rocailles calc., 2400 m, 22/06/1913; env. de Beuil, Cime de Cluos, 2100 m, 15/07/1898; Tête des Anguilles, 17/07/1898 (Charpin & Salanon 1985); Vallone Rabuons (Zappa, 1990); Lacs de Morgon pareti lat W lago, 2501 m; Maison Forestiere de Tortisse, 2231 m; Refuge de Vens pareti sul lato E lungo il fiume, 2419 m (Arroyo Gutiérrez 2005). Val Var: rochers à Entraunes, 10/07/1864; Estenc, Roche Grande, 30/5 & 05/09/1875; Col de Sanguinière près Estenc, 01/08/1885; Sanguinière, 11/7 6 19/08/1888, Vidal (Charpin & Salanon 1985); sulla strada del Col de la Cayolle a meno di un chilometro a nord del passo sulle rocce (Basses Alpes) (Kress 1969). Val Verdon: La Condamine – Beauvezer (Rouy 1908). Val Vesubie: sopra La Giandola - S. Martin Lantosque (Bicknell 1885); Prajet au Colle delle Finestre, 2250 m (Barbero & Bono 1967); strada per Bollene Vesubie quasi al Col du Turini; Madonna delle Finestre; Lac Trecolpas a N di Madonna Finestre (Kress 1969); in rupibus montis "Balma de la Frema" prope St-Martin-Vésubie, solo calcareo, 2240, 06/1895, leg. *Vidal*; M. Tournairet, 06/06/1884, leg. *Rastoin Brémond*; chémin entre San Dalmazzo de Valdeblora et Venanson, 01/07/1875 (Charpin & Salanon 1985); Vallon Sangué sentiero per i Lacs Bessons, 2244 m; Refuge de Cougoudre pareti a N del rifugio, 2199 m; Praire de Fenestre sentieri per il Passo dei Ladri pareti sul lato E, 2254 m; Cima W delle Finestre, 2662 m; fine de le pointe André, 2440 m; Vallette Escure pareti a W del fiume, 2343 m (Arroyo Gutiérrez 2005). Val Ubaye: Maurin (Rouy 1908). **Italy** – Albenga: M. Carmo, Gismondi, 1950; M. Carmo sopra Albenga (Charpin & Salanon

1985); Vallée d'Arroscia, M. Castellermo sur Onzo, rochers à l'Ubac, grès, 900-1000 m, 08/06/1914; entre Mendatica et Ponia Rocca, 06/07/1882 (Charpin & Salanon 1985); Val Arroscia: Colle di Nava; M. Castellermo (Zappa 1990). Val Aveto: Rocca di Cornin, 1300-1350 m; M. La Guardiola, 1423 m; Rocca Marsa, 1500 m; Passo Roncalla /loc. Pianazza, 1500 m; Passo Roncalla /M. Spiaggio, 1470 m (Bernardello & Martini 1993). Val Corsaglia: Cima Verzera, rochers calc, 1900 m, 04/08/1900; Bocchin Brignola au N du Mongioje, rochers calc., 07/08/1900 (Charpin & Salanon 1985). Val Gesso: rocce Bisté (Marguareis), 2550 m; Mt. Clapiere entre 2700-2750 m; Mt. Malinvern, 2700 m; Cima Gorgia Cagna, 2650 m; Ray della Siula (Gruppe du Gelas), 2550 m; Crête de Maura, 2375 m; Cima del Brochan, 2750 m; Rocca dell'Abisso, 2500 m; Vallée de la Meris prés du Lac Sottano della Sella, 2000 m; Vallée de la Rovina prés della Sella, 2100 m; falaises du Mont Matto, 2200 m; Vallée de la Vallette, rochers prés du Colle Ciriegia, 2250 m; Vallon du Sabbione vers la Rocca dell'Abisso, 2150 m; Vallon di Lourousa, 2200 m (Barbero & Bono 1967); Entraque, 1100 m; Monte Lausa presso Entraque, 1300 m; Entraque: Vallone di Gherra, 1430 m; Monte Testa in Vallone Ciapusa, 1400 m; Pendici Monte Garbella in Entraque, 1550 m; Vallone Bousset, 900-1450 m; M. Guardiola, 1850-1900 m (Bono 1966); Valdieri, (Kress 1969); Cima Saben prés Valdieri-ville, rocher calc., 1400 m, 06/07/1909, leg. *Briquet*; Valdieri ville - aux carrières d'ardoise de la rive droite, calc. ardoiser, 800-900 m, 27/04/1885; rochers près du village d'Entraque, 10/07/1876; extrémité sup. du val della Rovina au-dessus d'Entraque, près des Gias de Fenestrelle, 02/08/1874; Colle della Garbella, entre les vals de Sabbione sur Entraque et les Val Grande sur Vernante, 11/07/1876; rochers à la sortie du val de Roaschia dans la Vallée du Gesso, 27/04/1885 (Charpin & Salanon 1985); R. Scregna e R. Vacciarampi; Comba dell'Infernetto; Caire di Porcera; Vallone del Sabbione - M. Colombo; NE Entraque (Zappa 1990); Colle del Mercantour - Col du Guilié, 2600; base del Rifugio Remondino, 2430 m; Ricovero Lombard - verso il Colle della Finestra, 2101 m; Lago sottano e soprano della Sella - sotto a Testa di Brasses, 2200 m; Rif. D.L.Bianco, 1893 m (Arroyo Gutiérrez 2005). Val Grande: B. Brusatà (tra T. Muriat e T. Bedon) (Zappa 1990); Palanfré Lago di Frisson, 2066 m (Arroyo Gutiérrez 2005). Val Nervia: Rio

Incisa M. Toraggio, 1300 m; M. Lega; Buggio; M. Marta; Rio Incisa M. Toraggio (Bicknell 1885); Valle Incisa (Kress 1969). Val Nure: Groppe di Selva presso "la Grotta", 1550 m (Romani & Alessandrini 2001; Bonafede 1992). Val Pennavaira: M. Galero (Gismondi 1950); versant N du Monte Nero, en montant depuis Castelbianco, 400-800 m, 27/06/1897, (Charpin & Salanon 1985); tra M. Armetta e M. Dubasso; M. Galero (Zappa 1990). Val Pesio: Ponzo di Lapazzo (Pesio), 2373 m (Barbero & Bono 1967); entre Pesio (Certosa) et Limone, 25/06/1872; rochers près des neiges fondantes Val Pesio, 12/06/1873 (Charpin & Salanon 1985). Val Roaschia: Valle di Roaschia, 760 m (Charpin & Salanon 1985); Vallone di Biale, presso Roaschia, 1000 m; presso Roaschia, 1250 m; Valle Roaschia rupi nel vallone di Biale, 1250 m; M. Testa in Vallone Ciapusa (Bono 1966); Val Ciapusa (Zappa 1990). Val Stura: Vallone di S. Anna Vinadio; M. Lausa (Bono 1966); Colle della Maddalena a 3 km da Grangie (CN) (Kress 1969); partie supe. du Vallon de Pouriac prés Argentera, 30/07/1895, leg. *Ferrari, Briquet & Caviller*; Vallon de Forneris près Bersezio et Ferriere, 29/07/1895; Vallon d'Aver lateral a la vallée Rio Freddo de Vinadio, 13/07/1895; Col dell'Arpion entre Valdieri et Vinadio, 27/07/1882, leg. *Vetter*; Col della Maddalena, 01/08/1895 (Charpin & Salanon 1985); Cima Revelli dal Bocchin d'Aseo; Vallone del Piz (Zappa 1990); Rif. Zanotti - Vallone del Piz, 2055 m; Vallone superiore di Pontebernardo Gias del Vallonetto, 1885 m (Arroyo Gutiérrez 2005). Val Tanaro: Monjoie; M. Galé (Charpin & Salanon 1985); Piz di Conolia (Barbero 1966); Mont Castello di Quarzina, 1800 m (Barbero & Bono 1967); Ponte di Nava (di fronte) (Kress 1969); Pizzo di Conolia sur Viozene, rochers calc., 2500 m, 06/08/1900; Monjoie rupi presso il Bocchin Aseo, 18/06/1894, leg. *Ferrari*; Cima Cinajera, rochers calc., 2150 m, 03/08/1900; Cima delle Colme sur Viozene, rochers calc., 2400 m, 09/08/1900; env. de Garessio Mont Galé, 1600 m, 01/07/1897 (Charpin & Salanon 1985); Bric Conolia versante S (Zappa 1990). Val Varaita: Col di Sampeyre; Col di Sampeyre / Cucchiales (Kress 1969). Val Vermenagna: Limone Tenda; Rupi sotto il castello di Maima Tenda (Charpin & Salanon 1985); Col di Tenda presso Limonetto; Col di Tenda (Kress 1969); entre Palanfré et Vernante, 12/07/1876; rochers à

l'altitude de Limone et près de cette ville, 10/08/1891; extrémité sup. du val San Giovanni sur Limone, 1200 m, 15/07/1876 (Charpin & Salanon 1985); Col di Tenda Italia (Zhang 2004).

Appendix II - *P. marginata* supplementary bibliographic fonts

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Appendix III – *P. marginata in situ* investigation results

VERIFIED LOCALITIES – **France** – Menton: Roccaseira (1220 m, NW, calcare, rocce nel bosco), [43°55’00’’N, 07°18’06’’E]; Mont Baudion (1141 m, NE, calcare, rocce in bosco misto), [43°48’02’’N, 07°26’10’’E]. Val Bevera: Punta Renuit M. Grammondo (1300 m, N, calcare, prato roccioso), [44°50’29’’N, 07°30’57’’E]; Authion (1852 m, SW, calcare, cenge erbose su parete), [43°59’36’’N, 07°25’36’’E]; tra Molinet e Sospel a valle di Notre Dame del Menour Gorges de Piaon (660 m, S, calcare, cenge erbose su parete), [43°55’00’’N, 07°24’29’’E]. Val Esteron: Clue de Saint Auban (985 m, N, calcare, cenge erbose su parete), [43°51’16’’N, 06°43’29’’E]. Val Roya: Monte Chajol (2137 m, SW, calcare, sfasciume), [44°06’05’’N, 07°31’30’’E]; rocce presso la città di Tenda (800 m, N, calcare, rocce), [44°05’03’’N, 07°35’40’’E]. Val Ubaye: Lac des Sagne (1989 m, E, calcare, cenge erbose su parete), [44°23’00’’N, 06°49’43"E]. Val Var: Col de Cayolle (2000 m, NE, silice, prato roccioso), [44°16’15’’N, 06°44’47’’E]; Monte Bruna Parte sup. del Vallone di fronte a Villars, riva destra del Var, tra i M. Bruna e dei Colletti (1430 m, N, calcare, rocce tra prato e bosco), [43°54’41’’N, 07°14’15’’E]. Val Vesubie: La Colmiane - Valdeblore (1749 m, NW, calcare, rocce), [44°04'37"N, 07°13'17"E]; Lago di Tres Colpas (1952 m, NW, silice, rocce), [44°06’52’’N, 07°19'36"E]. **Italy** – Albenga: Rocca Barbena (991 m, N, calcare, cenge erbose su parete), [44°09’28’’N, 08°07’39’’E]; Monte Carmo (1384 m, N, calcare, rocce nel bosco), [44°10’40’’N, 08°11’18’’E]; Magliolo, Bric dell'Agnellino (Loano), (1300 m, N, calcare, rocce nel bosco), [44°12’02’’N, 08°10’45’’E]. Val Arroscia: M. Fronté (2100 m, NW, calcare, prato roccioso), [44°03’19’’N, 07°45’25’’E]. Val Corsaglia: Monte Mondolè rupi della vetta (1972 m, E, silice, rocce in prato), [44°13’34’’N, 07°46’09’’E]. Val Gesso: Passo del Porco (2604 m, S, silice, rocce), [44°10'49"N, 07°18'57"E]; Gorge Reina - Vallone di Gherra (1536 m, N, calcare, rocce) [44°14'51"N, 07°25'31"E]; Lago Chiotas - Rocce di chiusura (2015 m, NE, silice, prato roccioso), [44°10’08’’N, 07°20’03’’E]; Vallone Saben (1100 m, SW, calcare, rocce), [44°17’44’’N, 07°24’25’’E]. Val Grande: Lago Frisson - Palanfrè (1625 m, N, calcare, prato roccioso),

[44°10’50’’N, 07°29’39’’E]. Val Maira: Vallone di Elva sbocco (1000 m, W, calcare, rocce), [44°29'58"N, 07°06'02"E]. Val Nervia: M. Arpetta (1600 m, NW, calcare, prato roccioso), [43°57'37"N, 07°35'16"E]. Val Pesio: Val Cravina (1410 m, NE, calcare, rocce in bosco e falesia), [44°13’48’’N, 07°37'58’’E]. Val Stura: Rio Freddo - Stura (1101 m, E, silice, rocce nel bosco), [44°17’39’’N, 07°09’43’’E]; Pontebernardo - Barricate (1373 m, N, calcare, cenge erbose su parete), [44°21’31’’N, 07°00’27’’E].

NEW POPULATIONS– **Italy** – Val Pennavaire: Monte Galero - M. della Guardia (1503 m, N/NE, calcare, cenge erbose su parete), [44°06'58’’N, 07°55'30"E]. Val Tanaro: Riserva delle Navette (1880 m, , calcare, cenge erbose su parete), [44°06'09"N, 07°42'58"E]; Monte Saccarello (2159 m, E, calcare, cenge erbose su parete), [44°03’41’’N, 07°42’52"E]. Val Varaita: Colle dell’Agnello (2553 m, E, silice, prato roccioso), [44°40’29"N, 06°59’24’’E]. Val Vermenagna: Cime du Bec Roux – Col di Tenda (1961 m, NE, calcare, falesia), [44°09’15’’N, 07°35’34’’E]; Colle Canelle - Col di Tenda (1892 m, N e S, calcare, falesia e rocce bordo strada), [44°90’10’’N, 07°34’41’’E]; Rocca dell'Abisso (Bassa di Pera) - Colle di Tenda (2140 m, N, silice, falesia), [44°08’19’’N, 07°31’21’’E].